REMARKS

Examiner Minh Nguyen is thanked for the thorough examination and search of the subject Patent Application.

According to the results of the examination the fourth paragraph of page 10 and the first paragraph of Page 11 have been amended to correct minor editorial problems.

In amended Fig. 2A missing resistors of voltage dividers 35 and 36 have been included and couplings of the other resistors of both voltage dividers have been corrected.

Claims 1, 2, 6, 9, 10, and 12 have been amended and Claims 3-5, 7-8, 20-21, and 26-44 have been canceled.

All Claims are believed to be in condition for Allowance, and that is so requested.

Reconsideration of objected claims 1-2, 12, 26-27, and 34, because of informalities, is requested based on the following remarks.

The informalities of claims 1, 2, and 12 have been corrected accordingly as advised. The other objected claims were canceled.

Reconsideration of the rejection of claims 3-5, 19-22, 28-30 and 40 under the first paragraph of 35 U.S.C. as failing to comply with the enablement requirement is requested, based on the following remarks.

Claims 3-5, and 20-21 have been canceled. As per claim 19 the last sentence of the second section of page 9 teaches the control of the velocity and the direction of the rotation of the DC-motor:

> "Important control signals for said control logic **33** are the **PWM** pulses to define the speed of the motor and the **DIR** bit, defining the direction of the rotation of the motor."

It is known to those skilled in art to use PWM pulses to control the speed of a DC-motor. As an example of this general knowledge, please see the attached tutorial about the usage of PWM pulses to control the speed of a DC-motor. (www.electronics-lab.com/projects/motor_light/003).

Claims 28-40 and claim 40 have been canceled.

Reconsideration of the rejection of claims 1-44 under 35 U.S.C.112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention is requested based on amended Claim 1 and on the following remarks.

The term "means to drive at the battery voltage level" has been clarified in the second element of claim 1:

"a power management module having an input and ~~an~~ outputs wherein the input is a battery voltage and a first~~the~~ output is a voltage to feed the low-side drivers and a second output feeds a charge pump~~means to drive at the battery voltage level~~;"

The term "a means to drive at the battery voltage level" lacking antecedent basis has been amended in the third element of claim 1:

"said charge pump~~means to drive at the battery voltage level~~ to drive the high-side drivers of the H-bridge and to drive a module~~means~~ for reverse supply protection, wherein said charge pump comprises a switching network controlled by a clocking scheme;"

The term "means for reverse supply protection" being unclear and lacking antecedent basis has been amended in the specification (fourth paragraph of page 10) :

"Said charge pump **20** is providing the voltage $\mathbf{V_{CP}}$ to said high-side drivers **26** and **27** and to an external reverse supply protection module **23**."

Furthermore claim 1 has been amended to provide an antecedent basis:

"said ~~means~~module for reverse supply protection;"

The element of claim 1 referring to the term "two high-side drivers" lacking antecedent basis, to the term "said charge pump" lacking antecedent basis, to the term

"two high-side drivers having an input and an output" being misdescriptive and to the term "a resistor" being misdescriptive has been amended in claim 1:

> "said two high-side drivers of the H-bridge having eachan inputs and an output, wherein thea first input of each high-side driver are said output control signals from said control logic circuit and a second input of each high-side driver is a voltage from said charge pumpcharge pump and eachthe output is driving one of twothe high-side transistors of said H-bridge via a resistor each;"

The term "two low-side drivers having an input and an output" being misdescriptive has been amended in the seventh element of claim 1:

> "said two low-side drivers having an input and an output, wherein thea first input of each low-side driverinput are said output control signals from said control logic circuit and a second input of each low-side driver is the first output voltage from of said power management module and eachthe output is driving one of twothe correspondent low-side transistors of said H-bridge;"

Furthermore the structural relationship of the two voltage dividers being confusing has been caused by an error in Fig. 2A. Fig. 2A has been amended accordingly as pointed out earlier in this amendment:

> "In amended Fig. 2A missing resistors of voltage dividers 35 and 36 have been included and couplings of the other resistors of both voltage dividers have been corrected."

Reconsideration of the rejection of claims 1-7 and 15-22 under 35 U.S.C. 103(a) as being unpatentable over US patent No. 5,119,000 issued to Schultz is requested, based on the following:

The Examiner has allowed claims 8-14 and 23-25 if rewritten to overcome the rejection(s) under 35 U.S.C. 112, second paragraph. Allowed claim 8 has been added to independent claim 1and claim 9 has been amended so that it is now dependent from claim 1, as follows:

9. (currently amended) The circuit of claim ~~8~~1 wherein said clocking scheme is a two-phase clocking scheme.

The midpoints of the two voltage dividers 35 and 36 of the present invention as shown in amended Fig. 2A are connected directly to the midpoints (42 and 43) of the H-bridge. In claim 1 of the present invention "two voltage dividers keeping the reference voltage of the high-side drivers on the voltage levels of the midpoints of the H-bridge" have been claimed.

The allowed claims 10-14 and 23-25 were kept in the patent application.

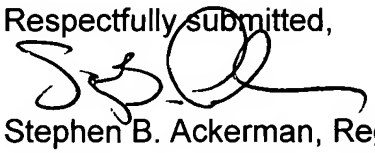
Claims 26-44 were canceled.

Applicants have reviewed the prior art made of record and not relied upon and have discussed their impact on the present invention above.

Allowance of all Claims is requested.

It is requested that should the Examiner not find that the Claims are now Allowable that the Examiner call the undersigned at 845-452-5863 to overcome any problems preventing allowance.

Respectfully submitted,



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PWM Motor/Light Controller

source: (C) G. Forrest Cook 1999

Pulse Width Modulator for 12 and 24 Volt applications

INTRODUCTION

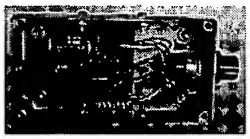
A pulse width modulator (PWM) is a device that may be used as an efficient light dimmer or DC motor speed controller. The circuit described here is a general purpose device that can control DC devices which draw up to a few amps of current. The circuit may be used in 12 Volt and 24 Volt systems with a few minor changes. This device has been used to control the brightness of an automotive tail lamp and as a motor speed control for small DC fans of the type used in computer power supplies. A PWM circuit works by making a square wave with a variable on-to-off ratio, the average on time may be varied from 0 to 100 percent. In this manner, a variable amount of power is transferred to the load. The main advantage of a PWM circuit over a resistive power controller is the efficiency, at a 50% level, the PWM will use about 50% of full power, almost all of which is transferred to the load, a resistive controller at 50% load power would consume about 71% of full power, 50% of the power goes to the load and the other 21% is wasted heating the dropping resistor. Load efficiency is almost always a critical factor in alternative energy systems. An additional advantage of pulse width modulation is that the pulses are at the full supply voltage and will produce more torque in a motor by being able to overcome the internal motor resistances more easily. Finally, in a PWM circuit, common small potentiometers may be used to control a wide variety of loads whereas large and expensive high power variable resistors are needed for resistive controllers. The main Disadvantages of PWM circuits are the added complexity and the possibility of generating radio frequency interference (RFI). RFI may be minimized by locating the controller near the load, using short leads, and in some cases, using additional filtering on the power supply leads. This circuit has some RFI bypassing and produced minimal interference with an AM radio that was located under a foot away. If additional filtering is needed, a car radio line choke may be placed in series with the DC power input, be sure not to exceed the current rating of the choke.

SPECIFICATIONS

PWM Frequency: 400 Hz
Current Capacity: 3 Amps with IRF521 FET, more with IRFZ34N FET
PWM circuit current: 1.5 ma @ 12V with no LED and no load
Operating Voltage: 12V or 24V depending on the configuration.

THEORY

The PWM circuit requires a steadily running oscillator to operate. U1a and U1d form a square/triangle waveform generator with a frequency of around 400 Hz. U1c is used to generate a 6 Volt reference current which is used as a virtual ground for the oscillator, this is necessary to allow the oscillator to run off of a single supply instead of a +/- voltage dual supply. U1b is wired in a comparator configuration and is the part of the circuit that generates the variable pulse width. U1 pin 6 receives a variable voltage from the R6, VR1, R7 voltage ladder. This is compared to the triangle waveform from U1-14. When the waveform is above the pin 6 voltage, U1 produces a high output. Conversely, when the waveform is below the pin 6 voltage, U1 produces a low output. By varying the pin 6 voltage, the on/off points are moved up and down the triangle wave, producing a variable pulse width. Resistors R6 and R7 are used to set the end points of the VR1 control, the values shown allow the control to have a full on and a full off setting within the travel of the potentiometer. These part values may be varied to change the behavior of the potentiometer. Finally, Q1 is the power switch, it receives the modulated pulse width voltage on the gate terminal and switches the load current on and off through the Source-Drain current path. When Q1 is on, it provides a ground path for the load, when Q1 is off, the load's ground is floating. Care should be taken to insure that the load terminals are not grounded or a short will occur. The load will have the supply voltage on the positive side at all times. LED1 is optional and gives a variable brightness response to the pulse width. Capacitor C3 smooths out the switching waveform and removes some RFI, Diode D1 is a flywheel diode that shorts out the reverse voltage kick from inductive motor loads. In the 24 Volt mode, regulator U2 converts the 24 Volt supply to 12 Volts for running the pwm circuit, Q1 switches the 24 Volt load to ground just like it does for the 12 Volt load. See the schematic for instructions on wiring the circuit for 12 Volts or 24 Volts. At the 1 amp current level, no heat sink is needed on Q1, if you will be switching more current, a heat sink is recommended. Q1 may be replaced with a higher current device such as an IRFZ34N, all of the current handling devices, switch S1, fuse F1, and the wiring between the FET, power supply, and load should be able to handle the maximum load current.



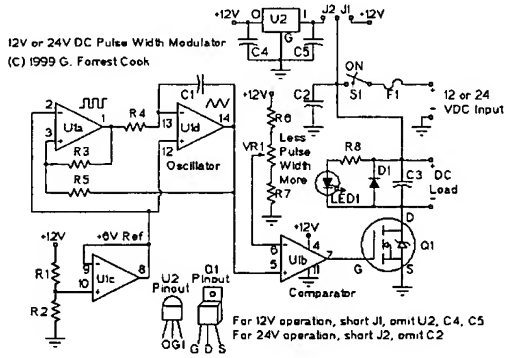
CONSTRUCTON

The prototype for this circuit was constructed on a regular IC proto board with parts and wires stuck into the proto board holes. One version of the finished circuit was used to make a variable speed DC fan, the fan was mounted on top of a small metal box and the PWM circuit was contained inside of the box (Fig 1). I built a simple circuit board (Fig 2) using a free circuit board CAD program, PCB (1) that runs on the Linux operating system. The circuit board image was printed on a PostScript laser printer onto a mask transfer product called Techniks Press-n-Peel blue film (2). The printed on film is then ironed on to a cleaned piece of single sided copper clad board. The board is etched with

Ferric Chloride solution. Holes are drilled with a fine gauge drill bit, parts are soldered in, and the board is wired to the power and load. This technique is great for producing working boards in a short time but is not suitable for large numbers of boards. A board pattern is shown in Fig 3, this may be photo-copied onto a piece of press-n-peel blue film. Alternately, the dead-bug construction method may be used, this involves taking a piece of blank copper PC board, glueing a wire-wrap IC socket to the board with 5 minute epoxy, then soldering all of the parts to the wire wrap pins. Grounded pins can be soldered directly to the copper board.

ALIGNMENT

No alignment should be necessary with this circuit.

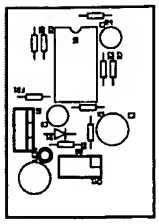


USE

This circuit will work as a DC lamp dimmer, small motor controller, and even as a small heater controller. It would make a great speed control for a solar powered electric train. I have not tried the circuit with larger motors, in theory, it should work in applications such as a bicycle motor drive system, if you experiment with this, be sure to include an easily accessible emergency power disconnect switch in case the FET shorts on. Wire the circuit for 12 Volts or 24 Volts as per the schematic, connect the battery to the input terminals, and connect the load to the output terminals, be sure not to ground either output terminal or anything connected to the output terminals such as a motor case. Turn the potentiometer knob back and forth, the load should show variable speed or light.

PARTS

U1:LM324N quad op-amp
U2:78L12 12 volt regulator
Q1:IRF521 N channel MosFet
D1:1N4004 silicon diode
LED1 Red LED
C1: 0.01uF ceramic disc capacitor, 25V
C2-C5:0.1uF ceramic disk capacitor, 50V
R1-R4:100K 1/4W resistor
R5:47K 1/4W resistor
R6-R7:3.9K 1/4W resistor
R8:2.7K 1/4W resistor
VR1:10K linear potentiometer
F1:3 Amp, 28V DC fast blow fuse
S1:toggle switch, 5 Amps



Amendments to the drawings

The attached sheet of drawings includes changes to Fig.2A. This sheet, which shows Fig. 2A, replaces the original sheet showing Fig. 2A. In the original Fig.2A resistor RS1, belonging to voltage divider 35, and resistor RS2, belonging to voltage divider 36, were erroneously omitted. Furthermore resistor RGH1, belonging to voltage divider 35, was erroneously coupled to ground instead to the first midpoint 42 of the H-bridge, and resistor RGH2 belonging to voltage divider 36, was erroneously coupled to ground instead to the second midpoint 43 of the H-bridge.

Attachment: Replacement sheet